Question1 :

Algorithm Used :-

Initializing the weight vector(W) with zeroes (initialize with any random values) . Multipying all the feature vector (X) with its label (Y) . Updating the weight vector if there is misclassification in every "STEP". Running until it converges .

a.) Without margin. (checking the dot product of feature vector(X) and weight vector (W) W.R.T "0" i.e. :- W.X > 0)

b.) Without margin. (checking the dot product of feature vector(X) and weight vector (W) W.R.T "b" i.e. :- W.X > b)

Initializing the weight vector(W) with zeroes (initialize with any random values) . Multipying all the feature vector (X) with its label (Y) . Updating the weight vector if there is misclassification in every "EPOCH". Running until it converges .

a.) Without margin. (checking the dot product of feature vector(X) and weight vector (W) W.R.T "0" i.e. :- W.X > 0)

b.) Without margin. (checking the dot product of feature vector(X) and weight vector (W) W.R.T "b" i.e. :- W.X > b)

Observation *:- Values such as the margin value(b) was taken by hit and trial method . Firstly I saw the number of digits in dot product of W and X vector and took the average of minimum and maximum value of the dot product of W and X.*

a.) Single Sample Perceptron with without margin

Epoch Number :- 1
Accuracy :- 0.996683774181
Precision :- 0.997475872309
Recall :- 0.996292451431

Epoch Number :- 2
Accuracy :- 0.998183971575
Precision :- 0.998516100312
Recall :- 0.998071788787

Epoch Number :- 3
Accuracy :- 0.998657718121
Precision :- 0.999109395874
Recall :- 0.998368436666

Epoch Number :- 4
Accuracy :- 0.998657718121
Precision :- 0.999109395874
Recall :- 0.998368436666

Epoch Number :- 5
Accuracy :- 0.998973549151
Precision :- 0.999258050156
Recall :- 0.998813408484

Epoch Number :- 6
Accuracy :- 0.999289380182
Precision :- 0.999554830093
Recall :- 0.999110056363

Epoch Number :- 7
Accuracy :- 0.999763126727
Precision :- 0.999851654057
Recall :- 0.999703352121

Epoch Number :- 8
Accuracy :- 0.999526253454
Precision :- 0.999555028182
Recall :- 0.999555028182

Epoch Number :- 9
Accuracy :- 0.998894591394
Precision :- 0.999257940042
Recall :- 0.998665084545

Epoch Number :- 10
Accuracy :- 0.999210422424
Precision :- 0.999258380303
Recall :- 0.999258380303

Epoch Number :- 11
Accuracy :- 0.999526253454
Precision :- 0.999555028182
Recall :- 0.999555028182

Epoch Number :- 12
Accuracy :- 0.999763126727
Precision :- 0.999851654057
Recall :- 0.999703352121

b.) Single Sample Perceptron with with margin

Epoch Number :- 1
Accuracy :- 0.99439399921
Precision :- 0.996575852315
Recall :- 0.992880450905

Epoch Number :- 2
Accuracy :- 0.997552309514
Precision :- 0.998514336651
Recall :- 0.996885197271

Epoch Number :- 3
Accuracy :- 0.998183971575
Precision :- 0.998812175204
Recall :- 0.997775140908

Epoch Number :- 4
Accuracy :- 0.998262929333
Precision :- 0.99896049896
Recall :- 0.997775140908

Epoch Number :- 5
Accuracy :- 0.998499802606
Precision :- 0.999109131403
Recall :- 0.998071788787

Epoch Number :- 6
Accuracy :- 0.998578760363
Precision :- 0.999109263658
Recall :- 0.998220112726

Epoch Number :- 7
Accuracy :- 0.998973549151
Precision :- 0.999258050156
Recall :- 0.998813408484

Epoch Number :- 8
Accuracy :- 0.998499802606
Precision :- 0.999109131403
Recall :- 0.998071788787

Epoch Number :- 9
Accuracy :- 0.999052506909
Precision :- 0.999406352033
Recall :- 0.998813408484

Epoch Number :- 10
Accuracy :- 0.999289380182
Precision :- 0.999554830093
Recall :- 0.999110056363

Epoch Number :- 11

Accuracy :- 0.999131464666
Precision :- 0.999554697937
Recall :- 0.998813408484

Epoch Number :- 12
Accuracy :- 0.999289380182
Precision :- 0.999406616229
Recall :- 0.999258380303

Epoch Number :- 13
Accuracy :- 0.999526253454
Precision :- 0.999703264095
Recall :- 0.999406704242

Epoch Number :- 14
Accuracy :- 0.99968416897
Precision :- 0.999703352121
Recall :- 0.999703352121

Epoch Number :- 15
Accuracy :- 0.999210422424
Precision :- 0.99940652819
Recall :- 0.999110056363

Epoch Number :- 16
Accuracy :- 0.999210422424
Precision :- 0.999554764025
Recall :- 0.998961732424

Epoch Number :- 17
Accuracy :- 0.999368337939
Precision :- 0.999406704242
Recall :- 0.999406704242

Epoch Number :- 18
Accuracy :- 0.999921042242
Precision :- 1.0
Recall :- 0.999851676061

Epoch Number :- 19
Accuracy :- 0.999447295697
Precision :- 0.999554962172
Recall :- 0.999406704242

Epoch Number :- 20
Accuracy :- 0.999447295697
Precision :- 0.999703220062
Recall :- 0.999258380303

Epoch Number :- 21
Accuracy :- 0.99968416897
Precision :- 0.999703352121

Recall :- 0.999703352121

Epoch Number :- 22
Accuracy :- 0.999763126727
Precision :- 0.999851654057
Recall :- 0.999703352121

c.) Batch perceptron without margin:

Epoch Number :- 1
Accuracy :- 0.532333201737
Precision :- 1.00
Recall :- 0.0

Epoch Number :- 2
Accuracy :- 0.467666798263
Precision :- 1.00
Recall :- 0.0

Epoch Number :- 3
Accuracy :- 0.526016581129
Precision :- 1.0
Recall :- 0.109611391279

Epoch Number :- 4
Accuracy :- 0.98847216739
Precision :- 0.999545592245
Recall :- 0.978789676654

Epoch Number :- 5
Accuracy :- 0.994551914726
Precision :- 0.997465334725
Recall :- 0.992287155147

Epoch Number :- 6
Accuracy :- 0.99573628109
Precision :- 0.995114006515
Recall :- 0.996885197271

Epoch Number :- 7
Accuracy :- 0.995104619029
Precision :- 0.99233490566
Recall :- 0.998516760605

Epoch Number :- 8
Accuracy :- 0.993604421634
Precision :- 0.989563427899
Recall :- 0.998516760605

Epoch Number :- 9
Accuracy :- 0.992972759574

Precision :- 0.98797124835
Recall :- 0.998961732424

Epoch Number :- 10
Accuracy :- 0.992499013028
Precision :- 0.987102447604
Recall :- 0.998961732424

Epoch Number :- 11
Accuracy :- 0.992025266482
Precision :- 0.985950534172
Recall :- 0.999258380303

Epoch Number :- 12
Accuracy :- 0.991709435452
Precision :- 0.985373701916
Recall :- 0.999258380303

Epoch Number :- 13
Accuracy :- 0.991314646664
Precision :- 0.984653610056
Recall :- 0.999258380303

Epoch Number :- 14
Accuracy :- 0.991077773391
Precision :- 0.984222059898
Recall :- 0.999258380303

Epoch Number :- 15
Accuracy :- 0.990998815634
Precision :- 0.984078293894
Recall :- 0.999258380303

Epoch Number :- 16
Accuracy :- 0.990998815634
Precision :- 0.984078293894
Recall :- 0.999258380303

Epoch Number :- 17
Accuracy :- 0.990919857876
Precision :- 0.983934569885
Recall :- 0.999258380303

Epoch Number :- 18
Accuracy :- 0.990998815634
Precision :- 0.984078293894
Recall :- 0.999258380303

Epoch Number :- 19
Accuracy :- 0.991314646664
Precision :- 0.984653610056
Recall :- 0.999258380303

Epoch Number :- 20
Accuracy :- 0.991314646664
Precision :- 0.984653610056
Recall :- 0.999258380303

Epoch Number :- 21
Accuracy :- 0.991393604422
Precision :- 0.984797544219
Recall :- 0.999258380303

Epoch Number :- 22
Accuracy :- 0.991709435452
Precision :- 0.985373701916
Recall :- 0.999258380303

Epoch Number :- 23
Accuracy :- 0.992025266482
Precision :- 0.985950534172
Recall :- 0.999258380303

Epoch Number :- 24
Accuracy :- 0.99210422424
Precision :- 0.986237188873
Recall :- 0.999110056363

Epoch Number :- 25
Accuracy :- 0.992262139755
Precision :- 0.986526069127
Recall :- 0.999110056363

Epoch Number :- 26
Accuracy :- 0.992499013028
Precision :- 0.98695970696
Recall :- 0.999110056363

Epoch Number :- 27
Accuracy :- 0.992814844058
Precision :- 0.987538484093
Recall :- 0.999110056363

Epoch Number :- 28
Accuracy :- 0.993051717331
Precision :- 0.987973012614
Recall :- 0.999110056363

Epoch Number :- 29
Accuracy :- 0.993209632846
Precision :- 0.988406222483
Recall :- 0.998961732424

Epoch Number :- 30

Accuracy :- 0.993209632846
Precision :- 0.988406222483
Recall :- 0.998961732424

Epoch Number :- 31
Accuracy :- 0.993367548362
Precision :- 0.988696418086
Recall :- 0.998961732424

Epoch Number :- 32
Accuracy :- 0.99376233715
Precision :- 0.989422653151
Recall :- 0.998961732424

Epoch Number :- 33
Accuracy :- 0.993920252665
Precision :- 0.989713445996
Recall :- 0.998961732424

Epoch Number :- 34
Accuracy :- 0.994157125938
Precision :- 0.990149955895
Recall :- 0.998961732424

Epoch Number :- 35
Accuracy :- 0.99439399921
Precision :- 0.990586851008
Recall :- 0.998961732424

Epoch Number :- 36
Accuracy :- 0.994788787998
Precision :- 0.991315866941
Recall :- 0.998961732424

Epoch Number :- 37
Accuracy :- 0.994788787998
Precision :- 0.991315866941
Recall :- 0.998961732424

Epoch Number :- 38
Accuracy :- 0.995025661271
Precision :- 0.991753791783
Recall :- 0.998961732424

Epoch Number :- 39
Accuracy :- 0.995025661271
Precision :- 0.991898659596
Recall :- 0.998813408484

Epoch Number :- 40
Accuracy :- 0.995341492302
Precision :- 0.992483419307

Recall :- 0.998813408484

Epoch Number :- 41
Accuracy :- 0.995657323332
Precision :- 0.993068868898
Recall :- 0.998813408484

Epoch Number :- 42
Accuracy :- 0.995815238847
Precision :- 0.993507451675
Recall :- 0.998665084545

Epoch Number :- 43
Accuracy :- 0.995894196605
Precision :- 0.993799822852
Recall :- 0.998516760605

Epoch Number :- 44
Accuracy :- 0.995894196605
Precision :- 0.993945658594
Recall :- 0.998368436666

Epoch Number :- 45
Accuracy :- 0.995973154362
Precision :- 0.994092453109
Recall :- 0.998368436666

Epoch Number :- 46
Accuracy :- 0.99605211212
Precision :- 0.99423929099
Recall :- 0.998368436666

Epoch Number :- 47
Accuracy :- 0.996131069878
Precision :- 0.994386172256
Recall :- 0.998368436666

Epoch Number :- 48
Accuracy :- 0.996210027635
Precision :- 0.994533096927
Recall :- 0.998368436666

Epoch Number :- 49
Accuracy :- 0.996288985393
Precision :- 0.994680065021
Recall :- 0.998368436666

Epoch Number :- 50
Accuracy :- 0.996525858666
Precision :- 0.995121230041
Recall :- 0.998368436666

Epoch Number :- 51
Accuracy :- 0.996525858666
Precision :- 0.995121230041
Recall :- 0.998368436666

Epoch Number :- 52
Accuracy :- 0.996604816423
Precision :- 0.995268372024
Recall :- 0.998368436666

Epoch Number :- 53
Accuracy :- 0.996683774181
Precision :- 0.995415557527
Recall :- 0.998368436666

Epoch Number :- 54
Accuracy :- 0.996762731938
Precision :- 0.99556278657
Recall :- 0.998368436666

Epoch Number :- 55
Accuracy :- 0.996762731938
Precision :- 0.99556278657
Recall :- 0.998368436666

Epoch Number :- 56
Accuracy :- 0.996841689696
Precision :- 0.995710059172
Recall :- 0.998368436666

Epoch Number :- 57
Accuracy :- 0.996841689696
Precision :- 0.995710059172
Recall :- 0.998368436666

Epoch Number :- 58
Accuracy :- 0.996920647454
Precision :- 0.995857375351
Recall :- 0.998368436666

Epoch Number :- 59
Accuracy :- 0.997078562969
Precision :- 0.996152138523
Recall :- 0.998368436666

Epoch Number :- 60
Accuracy :- 0.997078562969
Precision :- 0.996152138523
Recall :- 0.998368436666

Epoch Number :- 61
Accuracy :- 0.997157520726

Precision :- 0.996299585554
Recall :- 0.998368436666

Epoch Number :- 62
Accuracy :- 0.997157520726
Precision :- 0.996446550192
Recall :- 0.998220112726

Epoch Number :- 63
Accuracy :- 0.996999605211
Precision :- 0.99644549763
Recall :- 0.997923464847

Epoch Number :- 64
Accuracy :- 0.996999605211
Precision :- 0.99644549763
Recall :- 0.997923464847

Epoch Number :- 65
Accuracy :- 0.996920647454
Precision :- 0.996444971115
Recall :- 0.997775140908

Epoch Number :- 66
Accuracy :- 0.996920647454
Precision :- 0.996444971115
Recall :- 0.997775140908

Epoch Number :- 67
Accuracy :- 0.996920647454
Precision :- 0.996592087717
Recall :- 0.997626816968

Epoch Number :- 68
Accuracy :- 0.996920647454
Precision :- 0.996739291537
Recall :- 0.997478493029

Epoch Number :- 69
Accuracy :- 0.996920647454
Precision :- 0.996739291537
Recall :- 0.997478493029

Epoch Number :- 70
Accuracy :- 0.996999605211
Precision :- 0.996887044174
Recall :- 0.997478493029

d.) Batch Perceptron without margin

Algorithm :- *In the Batch version ,*

Rate_Value *(used in code)***:- 2.25**

Observation :- *Values such as the margin value was taken by hit and trial method . Firstly I saw the number of digits in dot product of W and X vector and took the average of minimum and maximum value of the dot product of W and X.*

Epoch Number :- 1
Accuracy :- 0.467666798263
Precision :- 1.00
Recall :- 0.0

Epoch Number :- 2
Accuracy :- 0.532333201737
Precision :- 0.532333201737
Recall :- 1.0

Epoch Number :- 3
Accuracy :- 0.975286221871
Precision :- 0.955763504892
Recall :- 0.999851676061

Epoch Number :- 4
Accuracy :- 0.995499407817
Precision :- 0.993066824015
Recall :- 0.998516760605

Epoch Number :- 5
Accuracy :- 0.995104619029
Precision :- 0.996728138013
Recall :- 0.994067042421

Epoch Number :- 6
Accuracy :- 0.994315041453
Precision :- 0.997612652939
Recall :- 0.991693859389

Epoch Number :- 7
Accuracy :- 0.993920252665
Precision :- 0.998206009867
Recall :- 0.990358943934

Epoch Number :- 8
Accuracy :- 0.993130675089
Precision :- 0.998651281283
Recall :- 0.98843073272

Epoch Number :- 9
Accuracy :- 0.993130675089
Precision :- 0.998950367371
Recall :- 0.988134084841

Epoch Number :- 10
Accuracy :- 0.992972759574
Precision :- 0.998950052497
Recall :- 0.987837436962

Epoch Number :- 11
Accuracy :- 0.992577970786
Precision :- 0.999099099099
Recall :- 0.986947493325

Epoch Number :- 12
Accuracy :- 0.99242005527
Precision :- 0.999248798077
Recall :- 0.986502521507

Epoch Number :- 13
Accuracy :- 0.992262139755
Precision :- 0.999248572287
Recall :- 0.986205873628

Epoch Number :- 14
Accuracy :- 0.992262139755
Precision :- 0.999248572287
Recall :- 0.986205873628

Epoch Number :- 15
Accuracy :- 0.992262139755
Precision :- 0.999248572287
Recall :- 0.986205873628

Epoch Number :- 16
Accuracy :- 0.992183181998
Precision :- 0.999248459342
Recall :- 0.986057549689

Epoch Number :- 17
Accuracy :- 0.992262139755
Precision :- 0.999248572287
Recall :- 0.986205873628

Epoch Number :- 18
Accuracy :- 0.992262139755
Precision :- 0.999248572287
Recall :- 0.986205873628

Epoch Number :- 19
Accuracy :- 0.992341097513

Precision :- 0.999248685199
Recall :- 0.986354197567

Epoch Number :- 20
Accuracy :- 0.992814844058
Precision :- 0.999249361958
Recall :- 0.987244141204

Epoch Number :- 21
Accuracy :- 0.992893801816
Precision :- 0.999249474632
Recall :- 0.987392465144

Epoch Number :- 22
Accuracy :- 0.992972759574
Precision :- 0.999249587273
Recall :- 0.987540789083

Epoch Number :- 23
Accuracy :- 0.993051717331
Precision :- 0.999099909991
Recall :- 0.987837436962

Epoch Number :- 24
Accuracy :- 0.993288590604
Precision :- 0.99910031489
Recall :- 0.988282408781

Epoch Number :- 25
Accuracy :- 0.993367548362
Precision :- 0.999100449775
Recall :- 0.98843073272

Epoch Number :- 26
Accuracy :- 0.993525463877
Precision :- 0.999100719424
Recall :- 0.988727380599

Epoch Number :- 27
Accuracy :- 0.993446506119
Precision :- 0.998950996553
Recall :- 0.988727380599

Epoch Number :- 28
Accuracy :- 0.993683379392
Precision :- 0.998951467945
Recall :- 0.989172352418

Epoch Number :- 29
Accuracy :- 0.99376233715
Precision :- 0.998951624981
Recall :- 0.989320676357

Epoch Number :- 30
Accuracy :- 0.993841294907
Precision :- 0.998951781971
Recall :- 0.989469000297

Epoch Number :- 31
Accuracy :- 0.993920252665
Precision :- 0.998802574465
Recall :- 0.989765648176

Epoch Number :- 32
Accuracy :- 0.993920252665
Precision :- 0.998802574465
Recall :- 0.989765648176

Epoch Number :- 33
Accuracy :- 0.993999210422
Precision :- 0.998802753667
Recall :- 0.989913972115

Epoch Number :- 34
Accuracy :- 0.994315041453
Precision :- 0.99865430622
Recall :- 0.990655591813

Epoch Number :- 35
Accuracy :- 0.994315041453
Precision :- 0.998505231689
Recall :- 0.990803915752

Epoch Number :- 36
Accuracy :- 0.994315041453
Precision :- 0.998505231689
Recall :- 0.990803915752

Epoch Number :- 37
Accuracy :- 0.994315041453
Precision :- 0.998356246264
Recall :- 0.990952239691

Epoch Number :- 38
Accuracy :- 0.994551914726
Precision :- 0.998356982823
Recall :- 0.99139721151

Epoch Number :- 39
Accuracy :- 0.994709830241
Precision :- 0.998357473496
Recall :- 0.991693859389

Epoch Number :- 40

Accuracy :- 0.994867745756
Precision :- 0.998357963875
Recall :- 0.991990507268

Epoch Number :- 41
Accuracy :- 0.994946703514
Precision :- 0.998358208955
Recall :- 0.992138831207

Epoch Number :- 42
Accuracy :- 0.995341492302
Precision :- 0.998359433259
Recall :- 0.992880450905

Epoch Number :- 43
Accuracy :- 0.995420450059
Precision :- 0.9983596779
Recall :- 0.993028774844

Epoch Number :- 44
Accuracy :- 0.995578365574
Precision :- 0.998360166965
Recall :- 0.993325422723

Epoch Number :- 45
Accuracy :- 0.995578365574
Precision :- 0.998211624441
Recall :- 0.993473746663

Epoch Number :- 46
Accuracy :- 0.995578365574
Precision :- 0.998063170441
Recall :- 0.993622070602

Epoch Number :- 47
Accuracy :- 0.995578365574
Precision :- 0.998063170441
Recall :- 0.993622070602

Epoch Number :- 48
Accuracy :- 0.995578365574
Precision :- 0.998063170441
Recall :- 0.993622070602

Epoch Number :- 49
Accuracy :- 0.995657323332
Precision :- 0.997915115413
Recall :- 0.993918718481

Epoch Number :- 50
Accuracy :- 0.995657323332
Precision :- 0.997915115413

Recall :- 0.993918718481

Epoch Number :- 51
Accuracy :- 0.99573628109
Precision :- 0.997767192617
Recall :- 0.99421536636

Epoch Number :- 52
Accuracy :- 0.995894196605
Precision :- 0.997767857143
Recall :- 0.994512014239

Epoch Number :- 53
Accuracy :- 0.995894196605
Precision :- 0.997767857143
Recall :- 0.994512014239

Epoch Number :- 54
Accuracy :- 0.995894196605
Precision :- 0.997767857143
Recall :- 0.994512014239

Epoch Number :- 55
Accuracy :- 0.99605211212
Precision :- 0.997768521273
Recall :- 0.994808662118

Epoch Number :- 56
Accuracy :- 0.996210027635
Precision :- 0.997769185009
Recall :- 0.995105309997

Epoch Number :- 57
Accuracy :- 0.996210027635
Precision :- 0.997769185009
Recall :- 0.995105309997

Epoch Number :- 58
Accuracy :- 0.99636794315
Precision :- 0.99776984835
Recall :- 0.995401957876

Epoch Number :- 59
Accuracy :- 0.99636794315
Precision :- 0.99776984835
Recall :- 0.995401957876

Epoch Number :- 60
Accuracy :- 0.99636794315
Precision :- 0.99776984835
Recall :- 0.995401957876

Epoch Number :- 61
Accuracy :- 0.996525858666
Precision :- 0.997770511296
Recall :- 0.995698605755

Epoch Number :- 62
Accuracy :- 0.996525858666
Precision :- 0.997770511296
Recall :- 0.995698605755

Epoch Number :- 63
Accuracy :- 0.996525858666
Precision :- 0.997770511296
Recall :- 0.995698605755

Epoch Number :- 64
Accuracy :- 0.996683774181
Precision :- 0.997771173848
Recall :- 0.995995253634

Epoch Number :- 65
Accuracy :- 0.996762731938
Precision :- 0.997771504977
Recall :- 0.996143577573

Epoch Number :- 66
Accuracy :- 0.996762731938
Precision :- 0.997623644735
Recall :- 0.996291901513

Epoch Number :- 67
Accuracy :- 0.996762731938
Precision :- 0.997623644735
Recall :- 0.996291901513

Epoch Number :- 68
Accuracy :- 0.996762731938
Precision :- 0.997623644735
Recall :- 0.996291901513

Epoch Number :- 69
Accuracy :- 0.996762731938
Precision :- 0.997475872309
Recall :- 0.996440225452

Epoch Number :- 70
Accuracy :- 0.996762731938
Precision :- 0.997475872309
Recall :- 0.996440225452

Question 2

a.) Relaxation algorithm + margin

Algorithm :- *Used the algorithm as was asked in the question :P .
Implemented the algorithm "Algorithm 9 (Single-sample relaxation with
margin)" from R.Duda*

Rate_Value *(used in code)***:- 2.25**

Observation :- *Values such as the margin value(b) was taken by hit and trial
method . Firstly I saw the number of digits in dot product of W and X vector
and took the average of minimum and maximum value of the dot product of W
and X.*

Epoch Number :- 1
Accuracy :- 0.962962962963
Precision :- 0.96484375
Recall :- 0.99797979798

Epoch Number :- 2
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 3
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 4
Accuracy :- 0.964912280702
Precision :- 0.96484375
Recall :- 1.0

Epoch Number :- 5
Accuracy :- 0.962962962963
Precision :- 0.962890625
Recall :- 1.0

Epoch Number :- 6
Accuracy :- 0.949317738791
Precision :- 0.949317738791
Recall :- 1.0

Epoch Number :- 7
Accuracy :- 0.949317738791

Precision :- 0.94921875
Recall :- 1.0

Epoch Number :- 8
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 9
Accuracy :- 0.95126705653
Precision :- 0.951171875
Recall :- 1.0

Epoch Number :- 10
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 11
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 12
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 13
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 14
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 15
Accuracy :- 0.95126705653
Precision :- 0.95126705653
Recall :- 1.0

Epoch Number :- 16
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 17
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 18
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 19
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 20
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 21
Accuracy :- 0.953216374269
Precision :- 0.953125
Recall :- 1.0

Epoch Number :- 22
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 23
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 24
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 25
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

Epoch Number :- 26
Accuracy :- 0.95126705653
Precision :- 0.95126705653
Recall :- 1.0

Epoch Number :- 27
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 28

Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 29
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 30
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

Epoch Number :- 31
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 32
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 33
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 34
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 35
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 36
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 37
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 38
Accuracy :- 0.957115009747
Precision :- 0.957115009747

Recall :- 1.0

Epoch Number :- 39
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 40
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

Epoch Number :- 41
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 42
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 43
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 44
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 45
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 46
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 47
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 48
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 49
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 50
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 51
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 52
Accuracy :- 0.966861598441
Precision :- 0.966796875
Recall :- 1.0

Epoch Number :- 53
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 54
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 55
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 56
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 57
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 58
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 59
Accuracy :- 0.957115009747

Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 60
Accuracy :- 0.962962962963
Precision :- 0.962890625
Recall :- 1.0

Epoch Number :- 61
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 62
Accuracy :- 0.953216374269
Precision :- 0.953125
Recall :- 1.0

Epoch Number :- 63
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 64
Accuracy :- 0.95126705653
Precision :- 0.951171875
Recall :- 1.0

Epoch Number :- 65
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 66
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 67
Accuracy :- 0.953216374269
Precision :- 0.953125
Recall :- 1.0

Epoch Number :- 68
Accuracy :- 0.962962962963
Precision :- 0.962890625
Recall :- 1.0

Epoch Number :- 69
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 70
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 71
Accuracy :- 0.953216374269
Precision :- 0.953125
Recall :- 1.0

Epoch Number :- 72
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 73
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 74
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 75
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 76
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

Epoch Number :- 77
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 78
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 79
Accuracy :- 0.953216374269
Precision :- 0.953125
Recall :- 1.0

Epoch Number :- 80

Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 81
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 82
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 83
Accuracy :- 0.95126705653
Precision :- 0.951171875
Recall :- 1.0

Epoch Number :- 84
Accuracy :- 0.962962962963
Precision :- 0.962890625
Recall :- 1.0

Epoch Number :- 85
Accuracy :- 0.962962962963
Precision :- 0.962890625
Recall :- 1.0

Epoch Number :- 86
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 87
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 88
Accuracy :- 0.95126705653
Precision :- 0.951171875
Recall :- 1.0

Epoch Number :- 89
Accuracy :- 0.95126705653
Precision :- 0.951171875
Recall :- 1.0

Epoch Number :- 90
Accuracy :- 0.953216374269
Precision :- 0.953216374269

Recall :- 1.0

Epoch Number :- 91
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 92
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

Epoch Number :- 93
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 94
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 95
Accuracy :- 0.949317738791
Precision :- 0.94921875
Recall :- 1.0

Epoch Number :- 96
Accuracy :- 0.957115009747
Precision :- 0.95703125
Recall :- 1.0

Epoch Number :- 97
Accuracy :- 0.955165692008
Precision :- 0.955078125
Recall :- 1.0

Epoch Number :- 98
Accuracy :- 0.949317738791
Precision :- 0.94921875
Recall :- 1.0

Epoch Number :- 99
Accuracy :- 0.959064327485
Precision :- 0.958984375
Recall :- 1.0

Epoch Number :- 100
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

b.) The modified perceptron algorithm

Algorithm :- *In the modified version , i am constantly changing the rate with which it is converging , so as it is coming closer to convergence I am decreasing the value of rate.Used the same algorithm as in part A.*

Rate_Value *(used in code)***:- 2.25**

Rate_Decrement *(per epoch)* **:- 0.02**

Observation :- *As can be seen with the accuracy with the part (A) , it performs slighlty better . Values such as the margin value(b) was taken by hit and trial method . Firstly I saw the number of digits in dot product of W and X vector and took the average of minimum and maximum value of the dot product of W and X.*

Epoch Number :- 1
Accuracy :- 0.962962962963
Precision :- 0.96484375
Recall :- 0.99797979798

Epoch Number :- 2
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 3
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 4
Accuracy :- 0.966861598441
Precision :- 0.966796875
Recall :- 1.0

Epoch Number :- 5
Accuracy :- 0.962962962963
Precision :- 0.962890625
Recall :- 1.0

Epoch Number :- 6
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 7
Accuracy :- 0.953216374269
Precision :- 0.953125
Recall :- 1.0

Epoch Number :- 8
Accuracy :- 0.961013645224
Precision :- 0.9609375
Recall :- 1.0

Epoch Number :- 9
Accuracy :- 0.953216374269
Precision :- 0.953216374269
Recall :- 1.0

Epoch Number :- 10
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 11
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 12
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 13
Accuracy :- 0.957115009747
Precision :- 0.957115009747
Recall :- 1.0

Epoch Number :- 14
Accuracy :- 0.955165692008
Precision :- 0.955165692008
Recall :- 1.0

Epoch Number :- 15
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 16
Accuracy :- 0.959064327485
Precision :- 0.959064327485
Recall :- 1.0

Epoch Number :- 17

Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 18
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 19
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 20
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 21
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 22
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 23
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 24
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 25
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 26
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 27
Accuracy :- 0.961013645224
Precision :- 0.961013645224

Recall :- 1.0

Epoch Number :- 28
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 29
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 30
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 31
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 32
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 33
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 34
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 35
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 36
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 37
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 38
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 39
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 40
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 41
Accuracy :- 0.961013645224
Precision :- 0.961013645224
Recall :- 1.0

Epoch Number :- 42
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 43
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 44
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 45
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 46
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 47
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 48
Accuracy :- 0.966861598441

Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 49
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 50
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 51
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 52
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 53
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 54
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 55
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 56
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 57
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 58
Accuracy :- 0.968810916179
Precision :- 0.968810916179
Recall :- 1.0

Epoch Number :- 59
Accuracy :- 0.968810916179
Precision :- 0.968810916179
Recall :- 1.0

Epoch Number :- 60
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 61
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 62
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 63
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 64
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 65
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 66
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 67
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 68
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 69

Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 70
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 71
Accuracy :- 0.962962962963
Precision :- 0.962962962963
Recall :- 1.0

Epoch Number :- 72
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 73
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 74
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 75
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 76
Accuracy :- 0.964912280702
Precision :- 0.964912280702
Recall :- 1.0

Epoch Number :- 77
Accuracy :- 0.966861598441
Precision :- 0.966861598441
Recall :- 1.0

Epoch Number :- 78
Accuracy :- 0.968810916179
Precision :- 0.968810916179
Recall :- 1.0

Epoch Number :- 79
Accuracy :- 0.968810916179
Precision :- 0.968810916179

Recall :- 1.0

Epoch Number :- 80
Accuracy :- 0.968810916179
Precision :- 0.968810916179
Recall :- 1.0

Epoch Number :- 81
Accuracy :- 0.968810916179
Precision :- 0.968810916179
Recall :- 1.0

Epoch Number :- 82
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 83
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 84
Accuracy :- 0.968810916179
Precision :- 0.968810916179
Recall :- 1.0

Epoch Number :- 85
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 86
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 87
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 88
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 89
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 90
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 91
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 92
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 93
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 94
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 95
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 96
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 97
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 98
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 99
Accuracy :- 0.970760233918
Precision :- 0.970760233918
Recall :- 1.0

Epoch Number :- 100
Accuracy :- 0.970760233918

Precision :- 0.970760233918
Recall :- 1.0

[Q. 3] The code implementation was incomplete. Thus, file is not uploaded as per the instructions given. Manual Evaluation. Code submitted in a folder named "Incomplete"

[Q. 4] The code implementation was incomplete. Thus, file is not uploaded as per the instructions given. Manual Evaluation.Code submitted in a folder named "Incomplete"